The Claims

What is claimed is:

1. An integral micro-electro mechanical systems ("MEMS") switch adapted for selectively coupling an electrical signal present on a first input conductor connected to the MEMS switch to a first output conductor also connected to the MEMS switch, the MEMS switch comprising:

a monolithic layer of material having micro-machined therein:

a. a seesaw;

b. a pair of torsion bars that are disposed on opposite sides of and coupled to the seesaw, and which establish an axis about which the seesaw is rotatable; and

c. a frame to which ends of the torsion bars furthest from the seesaw are coupled, the frame supporting through the torsion bars the seesaw for rotation about the axis established by the torsion bars;

an electrically conductive first shorting bar carried at an end of the seesaw distal from the rotation axis established by the torsion bars;

a base that is joined to a first surface of the monolithic layer; and

a substrate that is bonded to a second surface of the monolithic layer which is distal from the first surface thereof to which the base is joined, the substrate having formed thereon:

a. a first electrode which is juxtaposed with a surface of the seesaw that is located to one side of the rotation axis established by the torsion bars, application of an electrical potential between the first electrode and the seesaw urging the seesaw to rotate in a first direction about the rotation axis established by the torsion bars; and

b. a first pair of switch contacts adapted to be connectable respectively to the first input conductor and to the first output conductor, and which:

i. are disposed adjacent to but spaced apart from the first shorting bar when no force is applied to the seesaw;

ii. when no force is applied to the seesaw are electrically insulated from each other; and

iii. the first shorting bar contacts upon application of a sufficiently strong force to the seesaw which urges the seesaw to rotate in the first direction about the rotation axis established by the torsion bars;

whereby upon rotation of the seesaw about the rotation axis established by the torsion bars in the first direction to such an extent that the first shorting bar contacts the first pair of switch contacts, the contacting first shorting bar electrically couples together the first pair of switch contacts.

2. The MEMS switch of claim 1 that is further adapted for selectively coupling an electrical signal present on a second input conductor connected to the MEMS switch to a second output conductor also connected to the MEMS switch:

wherein the seesaw carries a second shorting bar at an end of the seesaw that is located on an opposite side of the rotation axis from the first shorting bar; and

wherein the substrate also has formed thereon:

a. a second pair of switch contacts adapted to be connectable respectively to the second input conductor and to the second output conductor, and which:

i. are disposed adjacent to but spaced apart from the second shorting bar when no force is applied to the seesaw;

ii. when no force is applied to the seesaw are electrically insulated from each other; and

iii. the second shorting bar contacts upon application of a sufficiently strong force to the seesaw which urges the seesaw to rotate in a second direction about the rotation axis estab-

lished by the torsion bars that is opposite to the first direction;

whereby upon rotation of the seesaw about the rotation axis established by the torsion bars in the second direction to such an extent that the second shorting bar contacts the second pair of switch contacts, the contacting second shorting bar electrically couples together the second pair of switch contacts.

3. The MEMS switch of claim 2 wherein the substrate also has formed thereon a second electrode which is juxtaposed with a surface of the seesaw that is located to one side of the rotation axis established by the torsion bars which is opposite to the surface of the seesaw with which the first electrode is juxtaposed, application of an electrical potential between the second electrode and the seesaw urging the seesaw to rotate in the second direction about the rotation axis established by the torsion bars.

4. The MEMS switch of claim 1 that is further adapted for selectively coupling an electrical signal present on a second input conductor connected to the MEMS switch to the first output conductor:

wherein the seesaw carries a second shorting bar at an end of the seesaw that is located on an opposite side of the rotation axis from the first shorting bar; and

wherein the substrate also has formed thereon:

a. a second pair of switch contacts a first one of which is adapted to be connectable respectively to the second input conductor and a second one of which is connected to that one of the second pair of switch contacts which is adapted to be connectable to the first output conductor, and which:

i. are disposed adjacent to but spaced apart from the second shorting bar when no force is applied to the seesaw;

ii. when no force is applied to the seesaw are electrically insulated from each other; and

iii. the second shorting bar contacts upon application of a sufficiently strong force to the seesaw which urges the seesaw to rotate in a second direction about the rotation axis established by the torsion bars that is opposite to the first direction;

whereby upon rotation of the seesaw about the rotation axis established by the torsion bars in the second direction to such an extent that the second shorting bar contacts the second pair of switch contacts, the contacting second shorting bar electrically couples together the second pair of switch contacts.

5. The MEMS switch of claim 4 wherein the substrate also has formed thereon a second electrode which is juxtaposed with a surface of the seesaw that is located to one side of the rotation axis established by the torsion bars which is opposite to the surface of the seesaw with which the first electrode is juxtaposed, application of an electrical potential between the second electrode and the seesaw urging the seesaw to rotate in the second direction about the rotation axis established by the torsion bars.

6. The MEMS switch of claims 1 through 5 wherein a fusion bond joins the monolithic layer and the base.

7. The MEMS switch of claims 1 through 6 wherein material forming the monolithic layer is single crystal silicon (Si).

8. The MEMS switch of claims 1 through 7 wherein a sheet of electrically insulating material is interposed between the seesaw and shorting bar(s).

9. The MEMS switch of claims 1 through 8 wherein the base includes a cavity formed therein which abuts the first surface of the monolithic layer, and into which a portion of

the seesaw enters upon rotation of the seesaw about the axis established by the torsion bars.

10. The MEMS switch of claims 1 through 9 wherein:

the substrate has formed thereon electrical conductors that respectively carry electrical signals between the switch contacts and input and output conductors; and

the MEMS switch includes ground plate(s) which are disposed adjacent to and are electrically insulated from the electrical conductors.

11. The MEMS switch of claim 10 wherein the ground plate(s) are disposed on the monolithic layer.

12. The MEMS switch of claim 11 wherein the monolithic layer includes a cantilever which supports at a free end thereof a grounding island which at an end thereof which is distal from the cantilever carries a portion of the ground plate, the portion of the ground plate at the end of the grounding island being urged by force supplied by the cantilever into intimate contact with an electrical conductor that is disposed on the substrate.

13. A micro-electro mechanical systems ("MEMS") electrical contact structure adapted for forming an electrical contact between an electrical conductor that is disposed on a first layer of a MEMS device and an electrical conductor that is disposed on a second layer of the MEMS device, the MEMS electrical contact structure comprising:

a cantilever included in the second layer; and

an electrical contact island also included in the second layer which is supported at a free end of the cantilever, the electrical contact island at an end thereof which is distal from the cantilever carrying a portion of the electrical conductor that is disposed on the second layer, the portion of the electrical conductor at the end of the electrical contact island being urged by force supplied by the cantilever into

intimate contact with the electrical conductor that is disposed on the first layer.

14. A micro-electro mechanical systems ("MEMS") structure comprising:

a first layer having disposed thereon an electrical conductor; and

a second layer also having disposed thereon an electrical conductor, the second layer including:

a. a cantilever; and

b. an electrical contact island which is supported at a free end of the cantilever, the electrical contact island at an end thereof which is distal from the cantilever carrying a portion of the electrical conductor that is disposed on the second layer, the portion of the electrical conductor at the end of the electrical contact island being urged by force supplied by the cantilever into intimate contact with the electrical conductor that is disposed on the first layer.